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| Re: | Category: P802.16m/D3 comments for LB30b<br>Area: Sections 16.3.5.4 (DL PHY Structure – Pilot Structure) |
| Abstract | Multiplexing of Advanced Air Interface Frames with WirelessMAN-OFDMA currently requires a minimum of two 16m subframes in a DL frame. To enable a minimum of one 16m subframe on the DL, a four-symbol pilot format will be required if the six symbol subframe contains both a preamble and a MIMO midamble. This contribution proposes a four symbol pilot format for the purpose of providing better flexibility in multiplexing 16m with legacy WirelessMAN-OFDMA. |
| Purpose | Discuss and adopt |
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# A Four Symbol Pilot Format for Improved Support for TDM Multiplexing of 16m Subframes with WirelessMAN-OFDMA. (Sections 16.3.5.4 – DL PHY Structure – Pilot Structure)

Fred Vook, Mark Cudak, Bill Hillery, Eugene Visotsky, Anup Talukdar

**Motorola, Inc.**

## 1. Introduction

Multiplexing of Advanced Air Interface Frames with WirelessMAN-OFDMA currently requires a minimum of two 16m subframes in a DL frame. To enable a minimum of one 16m subframe on the DL, the single six-symbol 16m DL subframe may need to contain both a preamble and a MIMO midamble. As a result, a four-symbol pilot format will be required, which is not currently supported in the draft standard. This contribution proposes a four symbol pilot format for the purpose of providing better legacy support for mixed (16m & legacy) deployments.

The proposed pilot formats for one and two streams are formed by simply taking the existing six-symbol pilot format and discarding the right most two symbols. The proposed four- and eight-stream pilot formats are formed by simply taking the existing six-symbol pilot formats and discarding the third and fourth symbols. For one and two streams, the proposed four symbol formats have the same pilot density as what is already in the draft standard. The proposed four and eight stream formats have slightly increased pilot densities.

## 2. Proposed Text Changes

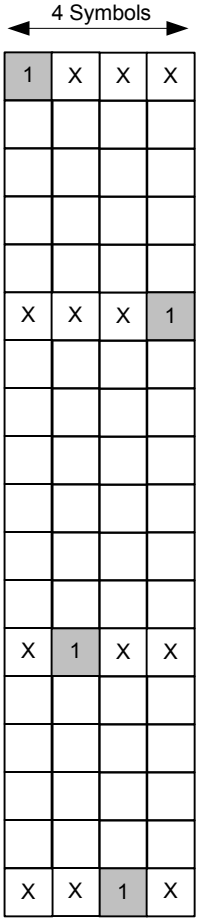
***[One and Two-Stream Pilot Formats - Section 16.3.5.4:***
***Modify the paragraph that starts on page 337, line 14 ]***

For the AAI subframe consisting of 5 symbols, the last OFDM symbol in each pilot pattern set shown in Figure 485, Figure 486, Figure 489, Figure 490 and Figure 491 is deleted. For the AAI subframe consisting of 4 symbols, the last two OFDM symbols in each pilot pattern set shown in Figure 485, Figure 486, Figure 489, Figure 490 and Figure 491are deleted. For the AAI subframe consisting of 7 symbols, the first OFDM symbol in each pilot pattern set shown in Figure 485, Figure 486, Figure 489, Figure 490 and Figure 491 is added as 7th symbol.

***[Four -Stream Pilot Formats - Section 16.3.5.4:***
***Modify the paragraph that starts on page 338, line 60 ]***

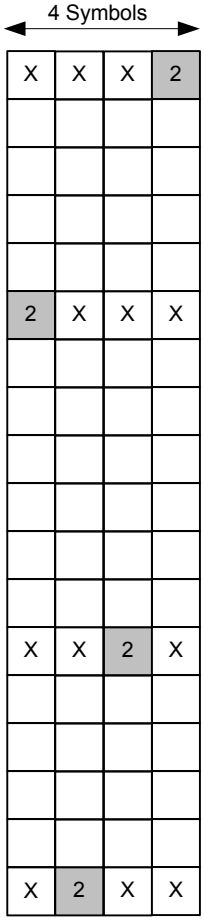
The pilot patterns on stream 0 - stream 3 for four pilot streams are shown in Figure 492 through Figure 495 respectively, with the subcarrier index increasing from top to bottom and the OFDM symbol index increasing from left to right. Subfigures (a) in Figure 492 through Figure 495 show the pilot pattern for four pilot streams in AAI subframe with six OFDM symbols; Subfigures (b) in Figure 492 through Figure 495 show the pilot pattern for four pilot streams in AAI subframe with five OFDM symbols; Subfigures (c) in Figure 492 through Figure 495 show the pilot pattern for four pilot streams in AAI subframe with seven OFDM symbols; Subfigures (d) in Figure 492 through Figure 495 show the pilot pattern for four pilot streams in AAI subframe with four OFDM symbols.

***[Modify Figure 492 by adding the following graphic as "Subfigure" (d):***



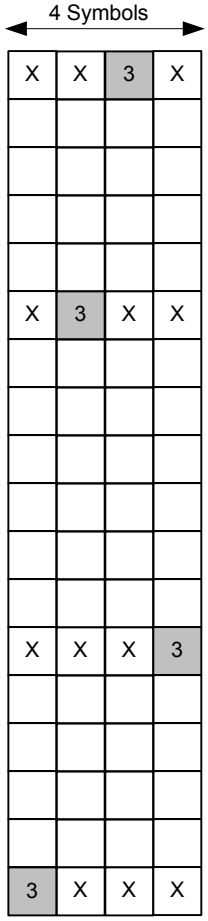

(d)

***[Modify Figure 493 by adding the following graphic as "Subfigure" (d):***



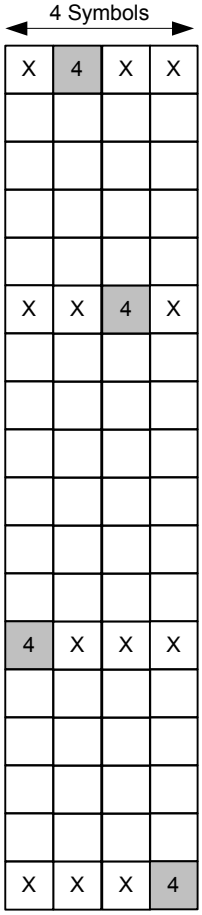

(d)

***[Modify Figure 494 by adding the following graphic as "Subfigure" (d):***




(d)

***[Modify Figure 495 by adding the following graphic as "Subfigure" (d):***

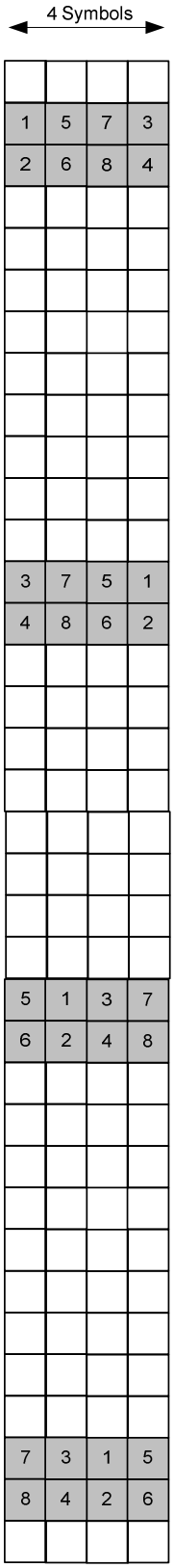



(d)

***[Eight -Stream Pilot Formats - Section 16.3.5.4:***
***Modify the paragraph that starts on page 340, line 55 ]***

The pilot patterns for eight pilot streams are shown in Figure 496 with the subcarrier index increasing from top to bottom and the OFDM symbol index increasing from left to right. Subfigure (a) in Figure 496 shows the pilot pattern for eight pilot streams in AAI subframewith six OFDM symbols; Subfigure (b) in Figure 496 shows the pilot pattern for eight pilot streams in AAI subframe with five OFDM symbols; Subfigure (c) in Figure 496 shows the pilot pattern for eight pilot streams in AAI subframe with seven OFDM symbols; Subfigure (d) in Figure 496 shows the pilot pattern for eight pilot streams in AAI subframe with four OFDM symbols.

***[Modify Figure 496 by adding the following graphic as "Subfigure" (d):***




(d)

## 3. Appendix: Example Link Simulation Results

In this appendix, we present example link simulation results showing the FER vs SNR performance of the A-MAP with the proposed two-stream format. As mentioned in the proposed text section, the proposed one and two-stream formats are formed by simply taking the existing six-symbol pilot format and discarding the last two symbols. As a result, the pilot overhead of the proposed one- and two-stream formats is the same (1/18) as the existing one- and two-stream pilot formats currently in the draft standard.

The parameters of the link simulations are shown in Table 1. Figure 1 shows the FER vs SNR performance of the proposed two-stream format for four symbols. For comparison, Figure 2 shows the FER vs SNR performance when the six-symbol two-stream format is used. The FER performance of all three interlaced pilot formats is shown in both Figure 1 and Figure 2.

Several points are worth noting from these simulation results. First, the FER performance of all three interlaced formats are approximately equal. Second, the existing six-symbol format suffers approximately 2 dB of channel estimation loss at a $10^{-2}$ FER. The proposed four-symbol format suffers approximately 2.5 dB of channel estimation loss at a $10^{-2}$ FER. The slight increase (0.5dB) in channel estimation loss is not unexpected since the four-symbol format has the same pilot density, but fewer pilots than the six-symbol format (due to the smaller size of the PRU). The alternative is to increase the overhead of the four-symbol pilot format, but this is not viewed as desirable at this time.

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|---|---|
| Channel type | UMA |
| PHY Configuration | UMA (all mini-bands) |
| Speed | 30 km/h |
| Allocation type | MAP LRUs (DRUs with time-first mapping) |
| FEC Block size | 56 bits |
| Modulation | QPSK |
| Coding | Rate 1/8 TBCC |
| MIMO TX format | OL-SFBC w/non-adaptive precoding |
| Number TX antennas | 2 |
| Number RX antennas | 2 |
| Receiver type | MMSE |
| Channel estimation | Non-ideal and ideal |

Table 1. LLS parameters

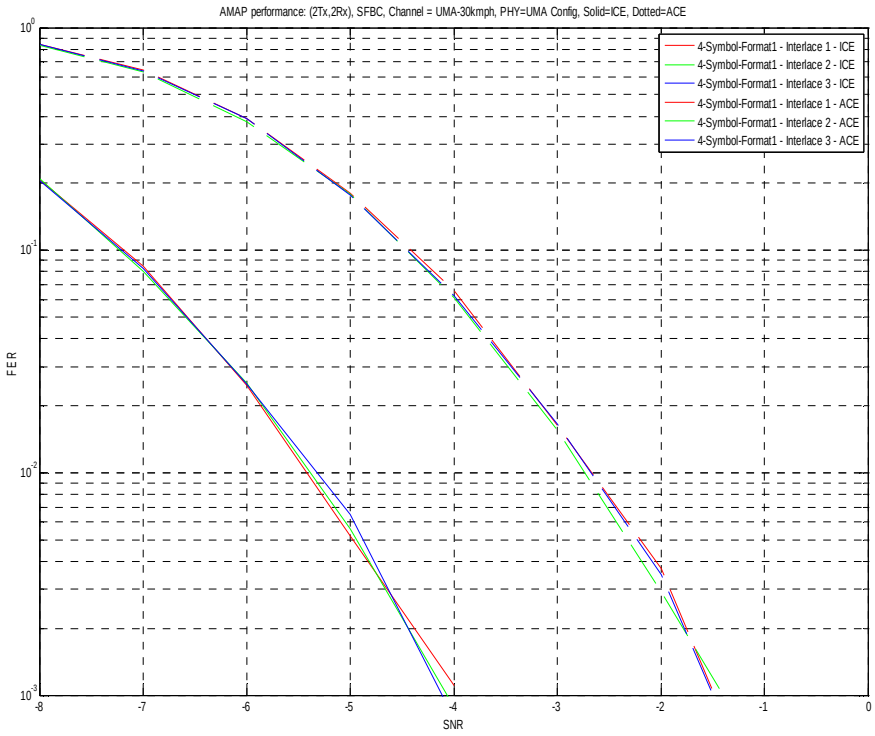


Figure 1. FER vs SNR performance – Proposed 4-symbol pilot format. AMAP – 2TX, 2RX, SFBC w/non-adaptive precoding. (ACE = actual 2D-MMSE channel estimation, ICE = ideal channel estimation)

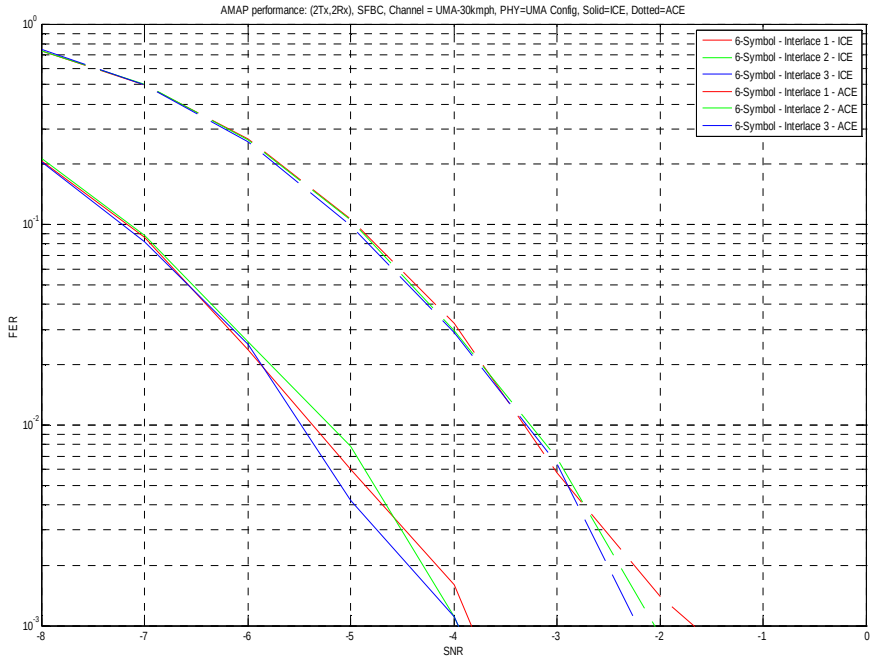


Figure 2. FER vs SNR performance – 6-symbol pilot format in D3. AMAP – 2TX, 2RX, SFBC w/non-adaptive precoding. (ACE = actual 2D-MMSE channel estimation, ICE = ideal channel estimation)